

Establishment and Application of Environmental Change Database during Historical Times

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I. Issues



Data



Main Progress



Establishment of Environmental Change Database during Historical Times and Its Function



Spatial distribution of sites from different data source



Expectation of Environmental Change Database

II. Data

According to the types of literature, Chinese historical document can be grouped into 3 categories:

- ❑ Ancient document and history records
- ❑ Local gazettes
- ❑ Archives

II. Data-- Ancient document and history records

Ancient document: Jing, Shi, Zi, and Ji

- ❑ "Jing" means the classics of the Confucian School, its annotation and proofreading were completed by later generations;
- ❑ "Shi" includes histories and chronicles of every dynasty;
- ❑ "Zi" is a general term for works in the fields of philosophy, politics, arts, sciences and technology;
- ❑ "Ji" covers literal works of individual scholars such as diaries and poems

II. Data-- Ancient document and history records

History records

It is a tradition in China for the new dynasty to compile the history of the previous dynasty. Documents, archives, and books of the last dynasty generally were the main sources for the official historian of the new dynasty. There are twenty-four editions of official histories, called the *Twenty-four Histories*(including 3280 volumes) , which has been published.

the first official history, *Shi-Ji (The Historical Records)*, was written by Sima Qian (145-86 B.C.), climate information was included in the Chapter of *Tian-Guan-Shu (The Book about Astronomy)*.

II. Data-- Ancient document and history records

Example: *Sui-Shu (The History of the Sui Dynasty)* recorded

“In the 3rd year of Daye, Emperor Yangdi (AD 607), more than 30 counties in Henan Provinces were flooded.”

This record did not specify the locations of the places, so that it quite possibly cause misunderstanding. However, it should not be neglected because it was used to be a yearly assessment about climate or disaster for a region.

☞ Before Ming Dynasty(AD 1470), climate informations in drought/flood or cold/warm change were extracted from Ancient document and history records.

II. Data-- Local gazettes

- ❑ Local gazettes(encyclopaedia in a place): contain climate, astronomy, geography, politics, economy, culture et al contents, which is one part of important cultural heritage, and main source of historical climate data for the periods of Ming and Qing Dynasty.
- ❑ Statistic shows that 12,863 sets of local gazettes were kept in the library of Beijing, Shanghai and Nanjing. now, more than 200,000 piece of information refer to the climate disaster.

II. Data-- Local gazettes

Example: gazettes of Zhanhua County recorded

“In summer and autumn, the 13th year of Chong-Zhen Reign (AD 1640) in Ming Dynasty, Zhanhua County, Shandong Province, there existed extreme drought and locust disaster, all of crops and seedling withered away. Many people starved to death. Some people killed each other for foods. (From The gazettes of Zhanhua County, Vol. 4, edited by Zhang Huiyi and compiled by Lianyin in the 17th year of Guang-Xu Reign (AD 1891) in Qing Dynasty)

II. Data--Archives

- ❑ Official archives are reliable data source for the historical climate reconstruction;
- ❑ Before the Ming Dynasty only few scattered pieces are kept with the evolution of dynasty;
- ❑ Fortunately, the Archives for the Qing Dynasty and Republic of China were kept perfectly. There were about 10 million volumes of archives;
- ❑ Most of them were collected together and stored in the Chinese First Historical Archive in the Palace Museum in Beijing. Some of them are also kept in the Palace Museum in Taipei, which part of the archives has been published.

II. Data--Archives

The most part of climate information of the Qing Dynasty was embedded in the memos to the emperor, which were classified into many categories:

- ✓ “*Yu-Xue Nong-Ye*” (*Rain, Snow and Agriculture*) focused on weather or climate and their impacts on agriculture or society;
- ✓ “*Tun-Ken Gen-Zuo*” (*Land Reclamation and Farming*);
- ✓ “*Huang-He Shui-Wen Zai-Qing*” (*Hydrology and Disaster in the valley of Yellow River*);
- ✓ “*Quan-Guo Shui-Li*” (*Water Resources all over the country*), *Zi-Ran-Zai-Hai* (*Natural Disasters*);
- ✓ “*Zi-Ran-Xian-Xiang*” (*Natural Phenomena*);
- ✓ *Tian-Wen Di-Li* (*Astronomy and Geography*)

II. Data--Archives

Example: The first memo in precipitation was reported by Li Xu, an official with responsibility for textile product, in the 1st day of the 7th month (of the Chinese lunar Calendar, i.e. Aug. 2) of the 32nd year of reign Kang-Xi (1693).

“In Suzhou and around area, the drought has occurred in this summer and people prayed for rain for a longtime. Fortunately, it rained in the 18th day of the 6th month (of the Chinese lunar Calendar, i.e. July 20) and recent days, the precipitation is probably enough for the crop-growth. In Suzhou, the land around river can be irrigated from the river, so the crop growth well and the harvest should be normal. However, the crop can not growth well in the higher-land and land on mountains, the harvest for those land should be 5~6 Fen (50~60% of bumper harvest).”

II. Data--Archives

From the beginning of Reign of Qiang-Long (AD.1736), the law and paradigm for reporting “*Yu-Xue Nong-Ye*” was settled. And from that time, reporting “*Yu-Xue Nong-Ye*” became a routine for every official.

II. Data--Archives

all archives, which focused on weather, climate and their impacts on agriculture and society, can be classified into 4 sub-categories:

- ❑ “*Qing-Yu-Lu*” (*Clear and Rain Records*) ;
- ❑ “*Yu-Xue-Fen-Cun*”(infiltration depth of rainfall and thickness of snowfall);
- ❑ harvest report;
- ❑ crop production price report .

II. Data--Archives

Qing-Yu-Lu (Clear and Rain Records)

Qing-Yu-Lu (Clear and Rain Records) is one type of archive related to climate, which was kept in the Chinese First National Historical Archive in Beijing.

□ It is a description reported by the local officials in the sky conditions (sun, rain, snow or wind direction and duration of the precipitation) every two hours.

□ began at AD.1685

II. Data--Archives

At present, some reports from 41 cities or counties have been found, but most of them are discontinuous. only four cities with long and relatively continuous records.

- ❑ Beijing (39.9°N , 116.4°E) has the longest records from 1724 to 1904.
- ❑ Nanjing (32.0°N , 118.7°E), cover the periods of 1722-1798
- ❑ Suzhou (31.3°N , 120.6°E), 1723-1810
- ❑ Hangzhou (30.2°N , 120.1°E), 1723-1773

II. Data--Archives

Yu-Xue-Fen-Cun

with high temporal and Spatial resolution and data length

- ❑ From AD.1736 to AD 1911;
- ❑ over the whole country(268 Fus of 18 provinces);
- ❑ take Cun(about 3.2cm) and Fen(about 0.32cm) in Qing Dynasty as measure unit.

Table 1. The statistic of *Yu-Xue-Fen-Cun* memos during 1736~1911 (pieces)

Reign	Qian-Long	Jia-Qing	Dao-Guang	Xian-Feng	Tong-Zhi	Guang-Xu	Xuan-Tong	Total/Average
Total	83400	28555	26628	7576	11685	54786	1151	213781
Pieces/year	1390	1142	888	689	899	1611	384	1215

II. Data--Archives

Harvest and food price

In General, local officials reported to the Emperor about harvest twice a year in summer and autumn, climate conditions can be known by agricultural harvest and food price information

on the 9th day of the 9th month in the 13th year of the Qian-Long Reign (Oct. 30, 1748), governor general Na-Su-Tu reported:

The actual harvest of autumn crop in Zhili Province:

Shuntian Fu (Beijing and around area now): Wanping, Daxing, Huairou, Pinggu, Wen'an, Zhuozhou, Liangxiang County: nine Fen; Changping, Shunyi, ...: eight Fen; Bazhou, Gu'an, ...: ten Fen; Yanqing County: six Fen; Xianghe County: seven Fen and five (7.5 Fen).....

II. Data--Archives

Table 2. The synonymy between harvest grade and description in harvest report in the Qing Dynasty

Harvest grade	Typical description
10 <i>Fen</i>	A best harvest year in decades, the greatest harvest
9 <i>Fen</i>	An abundant harvest year, prosperous harvest, a very rich year on food
8 <i>Fen</i>	A good harvest year, plentiful harvest, a high yield year
7 <i>Fen</i>	A average harvest year, normal harvest, a not bad yield
6 <i>Fen</i>	A moderate harvest year, mediocre harvest, a not good yield
5 <i>Fen</i>	A lean harvest year, deficient harvest, a bad yield
4 <i>Fen</i>	A disaster year, crop failure, need to relieve partly
3 <i>Fen</i>	A famine year, need relief to tide over famine areas
2 <i>Fen</i>	A almost no product year, people are starved to death
1 <i>Fen</i>	A worst year in decades, strewn with bodies of the starved everywhere

II. Data--Archives

Tab. 3 The food price in Shuntian Fu, Zhili Province in the 54th year
of Qiang-Long Reign

Dynastic year	AD	Month	Place	Wheat		Millet (<i>Li</i>)		Broomcorn		Millet (<i>Shu</i>)		Soybean	
				min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
54th year of Qiang-Long Reign	1780	1	Shuntian	1.15	1.98	1.02	1.85	0.70	1.20	0.76	1.60	0.73	1.53
54th year of Qiang-Long Reign	1780	2	Shuntian	1.15	1.99	1.12	1.85	0.78	1.20	0.75	1.60	0.79	1.53
54th year of Qiang-Long Reign	1780	3	Shuntian	1.15	2.00	1.17	1.85	0.84	1.20	0.75	1.60	0.79	1.53
54th year of Qiang-Long Reign	1780	4	Shuntian	1.15	2.00	1.17	1.85	0.84	1.25	0.75	1.75	0.79	1.53
54th year of Qiang-Long Reign	1780	5	Shuntian	1.15	2.00	1.17	1.90	0.84	1.25	0.75	1.75	0.79	1.53
54th year of Qiang-Long Reign	1780	6	Shuntian	1.20	2.01	1.17	1.90	0.82	1.25	0.74	1.75	0.78	1.53
54th year of Qiang-Long Reign	1780	7	Shuntian	1.26	1.99	1.17	1.90	0.82	1.25	0.74	1.75	0.78	1.58
54th year of Qiang-Long Reign	1780	8	Shuntian	1.28	2.00	1.27	2.25	0.84	1.37	0.76	1.81	0.80	1.65
54th year of Qiang-Long Reign	1780	9	Shuntian	1.28	2.00	1.37	2.25	0.86	1.37	0.78	1.91	0.82	1.65
54th year of Qiang-Long Reign	1780	10	Shuntian	1.28	2.20	1.37	2.25	0.92	1.37	0.83	2.07	0.83	1.65
54th year of Qiang-Long Reign	1780	11	Shuntian	1.28	2.20	1.40	2.25	0.93	1.61	0.83	2.23	0.83	1.65
54th year of Qiang-Long Reign	1780	12	Shuntian	1.28	2.20	1.03	2.25	0.93	1.66	0.83	2.23	0.83	1.62

II. Data--Archives

Archives of Republic of China

- ❑ covered the periods of 1912-1949
- ❑ kept in the Chinese Second National Historical Archives in Nanjing
- ❑ characteristics :
 - ✓ provide detailed qualitative description and quantitative statistics about natural disaster, climate and weather, agricultural activities and harvest.
 - ✓ usually first-hand writings and have relative high reliability.

II. Data--Archives

Example:

the survey report for disaster condition in Jiangsu Provinces in 1931 :

*“Lishui County, the **extreme drought** has lasted for one whole year, the paddy field becomes chapped, and without harvest, the people who suffered the disaster gathered with sadness”*

III. Progress

we have made some progress in data mining for studying climate change and its impacts on social and economy.

- ✓ Extract some useful climatic and agricultural information
- ✓ Established the environmental change database in historical times

III. Progress

Check and process of drought/flood proxy data

- ❑ Drought/flood grades for 137BC~1470AD at 63 sites(derived from ancient document);
- ❑ Drought/flood index for 1471~1950 at 85 sites (from local gazettes);
- ❑ Spatial interpolation to drought/flood grades for 1471~1950 at 120 sites(based on the the *Yearly Charts of Dryness/Wetness in China for the Last 500-year Period*);
- ❑ To reconstruct drought/flood grades series of 45 sites in the eastern part of China with year resolution.

IV. Spatial distribution of sites

Period: BC. 137-AD.1470

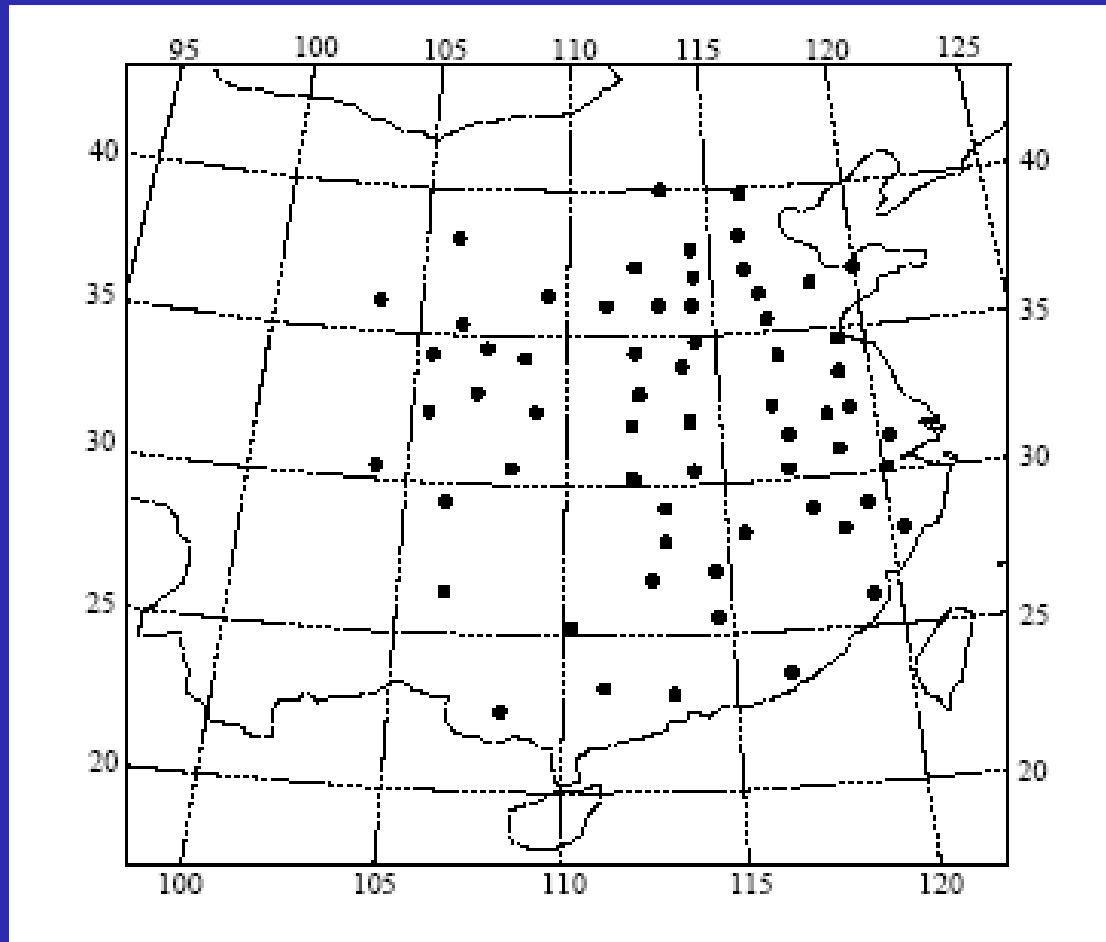


Fig. Drought/flood grades for 137BC~1470AD at 63 sites(derived from ancient document)

IV. Spatial distribution of sites

Period: AD. 1471-AD.1990

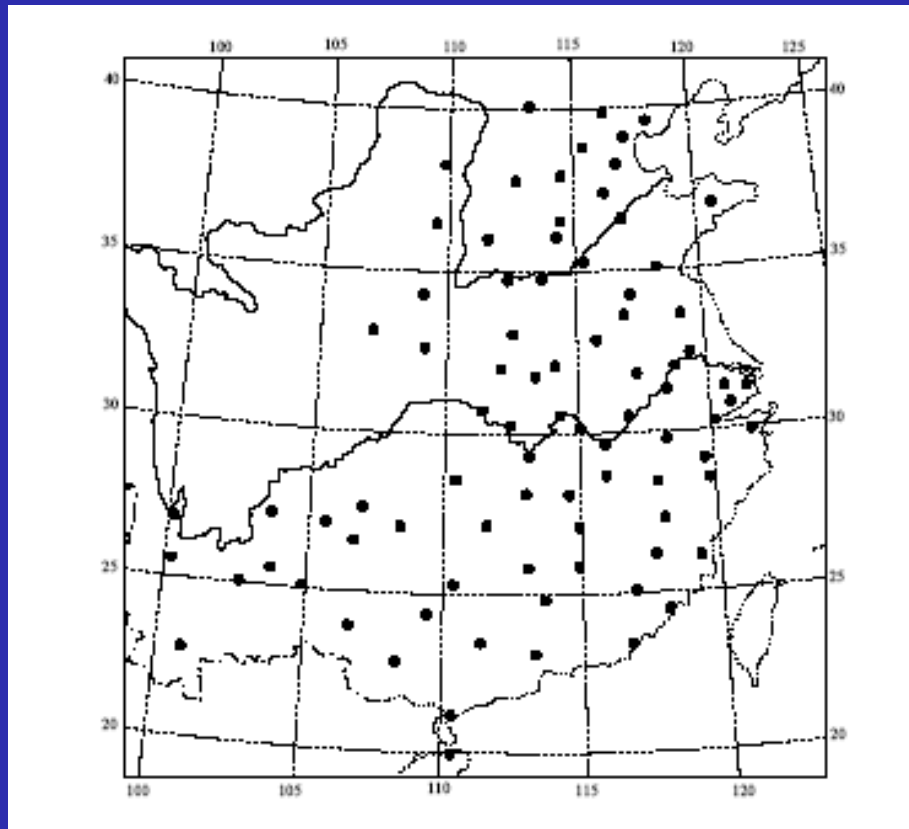


Fig. Drought/flood index for 1471~1950 at 85 sites
(from local gazettes)

IV. Spatial distribution of sites

Period: for the past 2000 years

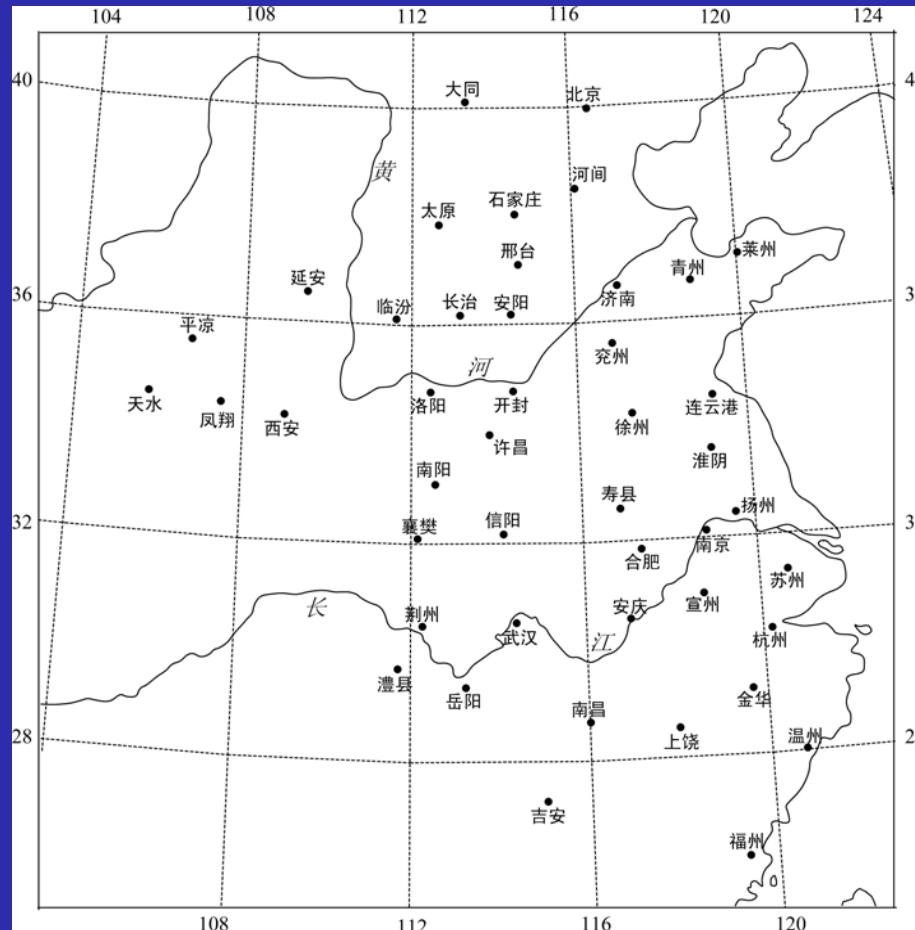


Fig. drought/flood grades series of 45 sites over the eastern part of China with year resolution

IV. Spatial distribution of sites

Period: 1736-1911

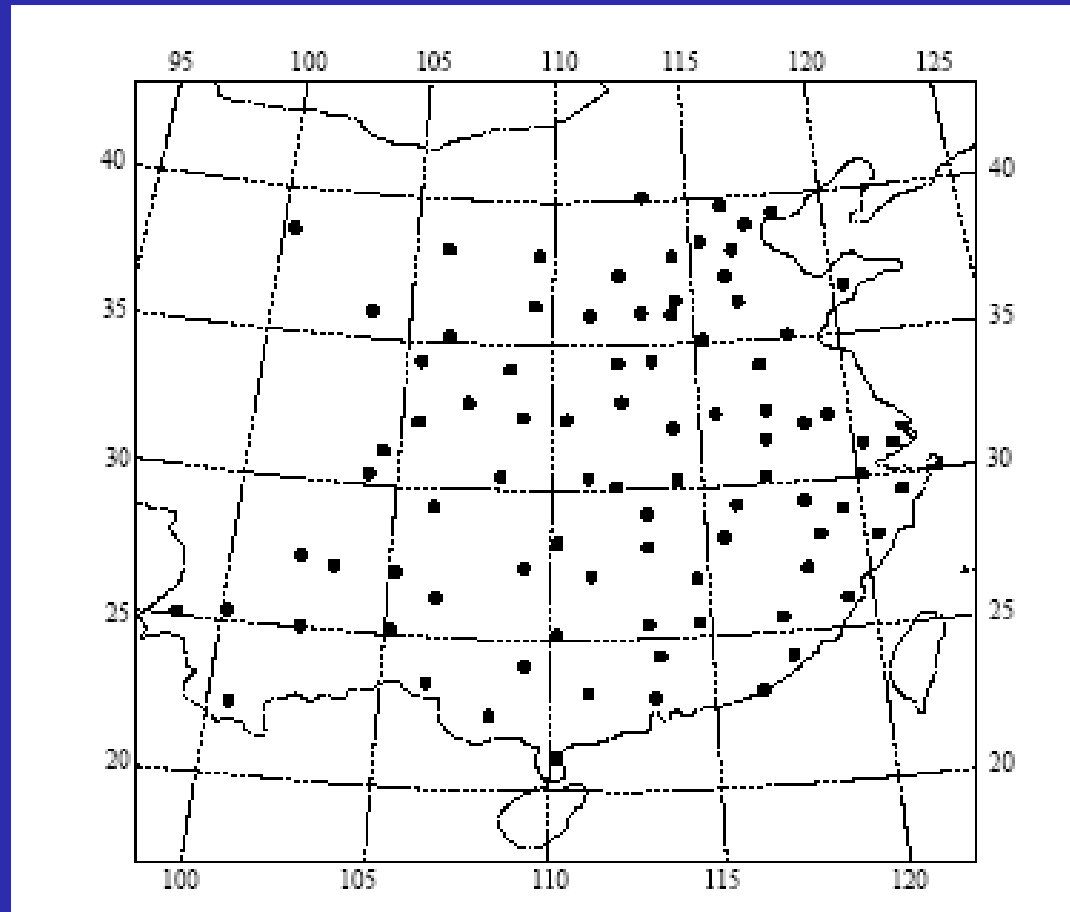


Fig. Agricultural harvest distribution of 87 sites
(derived from the archives in the Qing Dynasty)

IV. Spatial distribution of sites

Period: 1736-1911

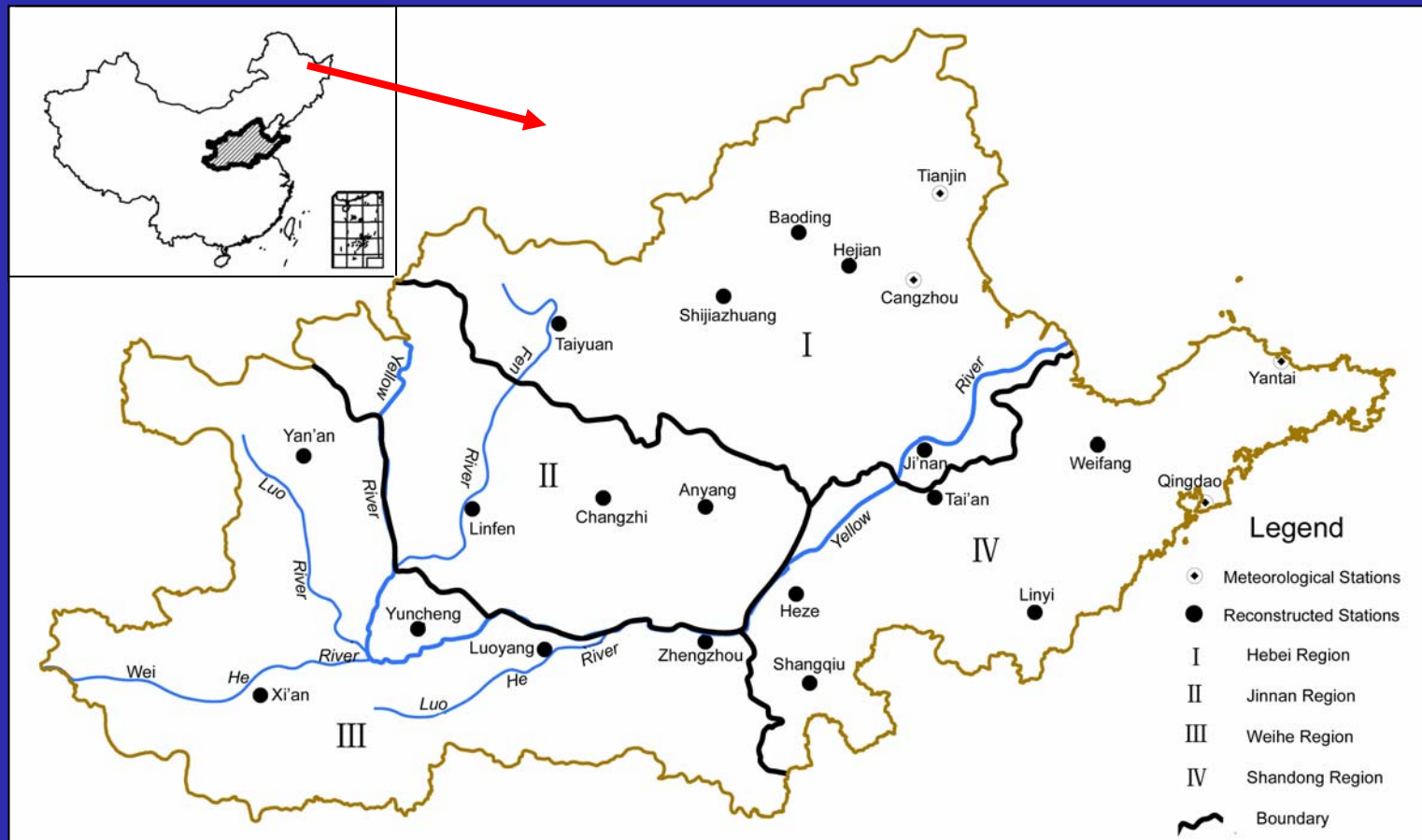


Fig. Region of precipitation reconstruction for the last 300 years

V. Historical environmental change database and function

Data source of the database

- ❑ Historical documents
- ❑ Instrumental observation data;
- ❑ Natural proof (high resolution series)

V. Historical environmental change database and function

Extraction format

年号	康熙五十一年	公元	1712	年	4	月	直隶	省	雨
								资 料	摘 录
								4-61~66	魏
								宫中档康熙朝奏折	
直隶巡抚赵弘燮									
今又据顺天府属之怀柔县报于三月初五日（10/4）得雨三寸，遵化固安等二州县各得雨一寸，固安县又于三月初九日（14/4）得雨一寸余，密云县三月初九至十日（14-15/4）得雨十分沾足，蓟州三月初五至初六日（10-11/4）得雨二寸，又三月初九至初十日得雨透足，……									
朱批：而已足了，恐再多时麦长的太高，也不甚好，口外偏多雨。									
三月二十六日（1/5）									

Fig. An example of original records form archives in Qing Dynasty

✓ Beside the reported contents, this record contains the information of year, month, province and reporter.

V. Historical environmental change database and function

Framework of database

The database was established with Microsoft Access.

Storage and management of data was realized by the datasheet. The frame include 3 layers.

- ❑ Original data;
- ❑ Derived data and records;
- ❑ Based 1 and 2, environmental change proxy data was reconstructed

☞ They are combined together by taking the key field as unique id of every datasheet

V. Historical environmental change database and function

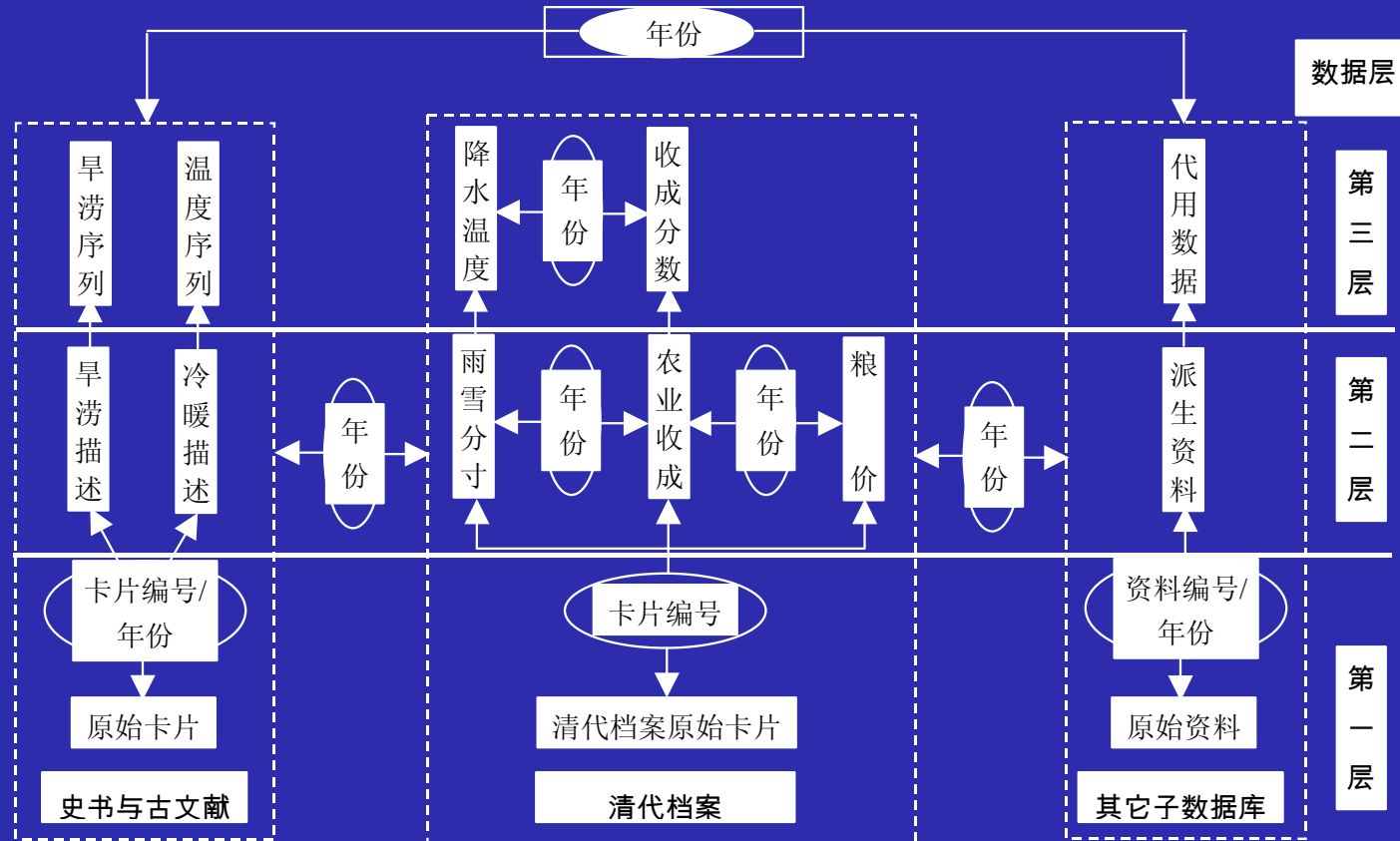


Fig. Design project of database

V. Historical environmental change database and function

Main function of the database

- ❑ Browse of datasheet
- ❑ Query and Statistics
- ❑ Edit and management
- ❑ Help and Introduction

V. Historical environmental change database and function

Based on the database, the following studies have expanded.

- ❑ Climate maps (137 breadth) in the Atlas of Chinese history have completed;
- ❑ High resolution precipitation series was reconstructed for the last 300 years over the Middle and Lower Reaches of the Yellow River, and climate forcing (ENSO, volcano activity and solar activity) impacting on the precipitation was discussed;
- ❑ The relationship between Climate Change and Harvest for the last 300 years—A case study in Xi'an;
- ❑ Reconstruction and analysis of two extreme floods events in 1755 and 1849 in Jiangsu and Anhui province.

VI. Expectation

In this database, not only contained temporal information of climate and environmental change, but also expressed the spatial characters.

And in the historical document, spatial record cell is administrative district(county, province),the spatial dynamic change will be shown for the historical times depending on GIS methods

VI. Expectation

Information share